Remarks

The present invention is directed to a method for reducing the particulate matter emissions produced during the combustion of diesel fuel in a diesel engine to a level below the particulate matter emissions produced during the combustion of Swedish Class 1 Diesel Fuel in a diesel engine, the method comprising using as the fuel an emulsion of a hydrocarbon fuel and water containing a non-ionic surfactant or mixture of non-ionic surfactants, wherein the hydrocarbon fuel is a Fischer-Tropsch (FT) derived hydrocarbon, or a mixture of a FT hydrocarbon fuel and a conventional fuel, the fuel emulsion having hydrocarbon particles substantially uniform in size in the range of about 0.1 to about 1.0 microns, said emulsion being a hydrocarbon-in-water emulsion.

The Examiner rejects claims 15 and 16 under 35 USC §112, first paragraph, as failing to comply with the written description requirement. The Examiner contends that the claims contain subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventors, at the time the application was filed, had possession of the claimed invention. The Examiner contends that the specification does not support the range of about 53 to 91.5% for the particulate matter emissions. The Examiner contends that there is nothing to indicate that the same amount of non-ionic surfactant was used or that the same fuel was used to prepare the emulsified fuels which produced the two data points. The Examiner argues that clearly there is something different about the fuels otherwise the results would be the same.

Applicants respectfully traverse this rejection.

Claims 15 and 16 recite that the particulate matter emissions produced upon combustion in an engine of the hydrocarbon-in-water emulsion are 53 to 91.5% lower

as compared to the particulate matter emissions produced upon combustion in an engine of Swedish Class 1 Diesel Fuel.

The values of 53% and 91.5% are taken from Figures 2 and 3 of the present specification. The experimental procedure used to generate the data in Figures 2 and 3 is recited in the Text beginning at page 7, Example 2.

In Example 2 it is stated that the emulsified Fischer-Tropsch fuel of Example 1 was compared to the same but unemulsified Fischer-Tropsch diesel fuel and to Swedish Class 1 Diesel Fuel using a Caterpillar 1Y540 single cylinder heavy duty research engine under 2 conditions, low load and medium load.

In Figure 2 under low load conditions the unemulsified FT diesel fuel exhibited the same emissions performance behavior as the Swedish Class 1 diesel, but the emulsified FT fuel (of Example 1) showed NO_x emissions 22% below Swedish Class 1 diesel and particulate matter emissions of 53% below.

In Figure 3 the results for the medium load run are reported. As had been stated at the beginning of Example 2, paragraph 26, the emulsified FT fuel of Example 1 was compared to unemulsified FT fuel as Swedish Class 1 diesel under low and medium load.

Thus, the results reported in Figure 3 (medium load) are for the same emulsified FT diesel fuel, unemulsified FT diesel fuel and Swedish Class 1 diesel fuel as was used to generate the results of Figure 2 (low load).

The fuels tested in Example 2 to give the results reported in Figures 2 and 3, therefore, are the same fuels, in the case of the emulsified FT fuel made using the same non-ionic surfactant in the same amount, because, as stated "The performance of

the emulsified Fischer-Tropsch diesel fuel of Example 1 was compared to the same but not emulsified Fischer-Tropsch diesel fuel and to Swedish Class 1 Diesel fuel ..." at low and medium load.

The difference in the results obtained, 53% lower emissions and 91.5% lower emissions than Swedish Class 1 Diesel fuel, is not a consequence of there being any difference in the emulsified FT fuel employed, but rather, in the conditions at which the test was performed, the 53% reduction being secured at low load and the 91.5% reduction being secured at medium load.

Thus, the test makes it clear that the two points referred to were both generated using the same fuel, the only difference being in the loads at which the two points were generated, low load and medium load. The data in the specification supports the claimed range. Claims 15 and 16 have been cancelled, their limitations being uncorporated into claims 1 and 9 respectively. The term "about" which appeared in front of "53%" in claims 15 and 16 has been deleted from the recitations inserted into claims 1 and 9, respectively.

The Examiner rejects claims 1, 5-10 and 12-14 under 35 USC §103(a) as unpatentable over WO 99/63025.

The Examiner argues that WO 99/63025 ('025) teaches a hydrocarbon-in-water emulsion comprising diesel fuel or F-T derived fuel, water, alcohol and a surfactant. The droplets are described as being less than 10 microns in size. The Examiner argues that '025 teaches that the fuel emulsion reduces NO_x and particulate matter.

The Examiner argues that while '025 does not teach how its fuel compares to Swedish Class 1 Diesel fuel no unobviousness is seen in this because '025 teaches a fuel that contains all the claimed components that applicants set forth in an emulsified

fuel and '025 uses that fuel on the same environment as applicant. The Examiner concludes that it would be reasonable to expect that the fuel of'025 would reduce particulate emissions as compared to Swedish Class 1 Diesel fuel.

The Examiner argues that while '025 does not teach a particle size of 0.1 to 1.0 micron it would have been obvious to optimize the particle size of '025 of 10 microns or less through routine experimentation to achieve the best results absent unexpected results.

The Examiner argues that there is nothing unobvious in the recitation of the fuel viscosity, the fuel of '025, containing the same components in the same range as applicants, being reasonably expected to have the same viscosity.

Applicants respectfully traverse this rejection.

Reference to Figures 2 and 3 demonstrate that particulate matter emissions generated upon combustion of the emulsion fuels are reduced from 53 to 91.5% as compared to Swedish Class 1 Diesel fuels. As previously demonstrated, the results presented in Figures 2 and 3 are generated from the combustion of identical emulsified FT fuels as per Example 1, the difference in the results being due to different load conditions in the tests, Figure 2 data being generated at low load and Figure 3 data being generated at medium load.

These results are secured when the emulsion fuel combusted has a hydrocarbon particle size of 0.1 to 1.0 micron. In the exemplified fuel the emulsion particle size was 0.7 microns on average with 95% being smaller than 1 micron.

In comparison in '025 the emulsion that is combusted is recited as having an emulsion particle size of 10 microns or less. All the data generated in '025 is based on

the emulsion having a particle size of 10 microns or less. Nothing in '025 would teach, suggest, imply or provide any motivation to one of ordinary skill in the art to investigate or test emulsions having particle sizes of 0.1 to 1 micron for differences in particulate emission or NO_x emissions.

As was stated in the previous amendment, in the Example at page 23 of '025, various fuels are compared. Fuels corresponding to EPA Emissions Certification Diesel fuel, CARB Diesel, RME (Rapeseed methyl ester) diesel, and Fischer-Tropsch diesel are utilized as are macro emulsions of these fuels in water. The emulsions are compared to the unemulsified fuels but specific results for each fuel/fuel emulsion pair are not individually reported. Rather, only general, non-specifically identified/attributed ranges are reported. In all cases, however, and even assuming that the lowest PM emissions results in each comparison correspond to the results from the best fuels tested, the improvement ranges from about 6% to about 44% under different load conditions presuming in each case that the best fuels correspond to an FT fuel and an FT fuel-in-water emulsion. This presumption is not arbitrary but rather is based on the teaching in the present application that (1) Swedish Class I Diesel is a standard low emissions reference diesel that produces about 40-50% lower PM emission than conventional diesel and (2) FT diesel has been shown to similarly produce 40-60% less PM emissions than conventional diesel. Thus, Swedish Class I Diesel and unemulsified FT diesel can be judged to be substantially equivalent in PM emissions.

Based on this it is fair and legitimate to presume that insofar as FT diesel and macro emulsions of FT diesel constitute one of the four fuel pairs reported, that the lowest PM emission level reported in each column would or could correspond to the emissions of the FT and macro emulsified FT fuel. As previously indicated, the reduction in PM emissions obtained in '025, based on the presumption, ranges from 6 to 44%.

By comparison, in the present invention the PM emissions achieved using a FT fuel-in-water emulsion having FT fuel particle of substantially uniform size in the range 0.1 to 1.0 microns are from 53 to 91.5% lower than the Swedish Class I diesel.

Nothing in '025 teaches, suggests or implies that the PM emissions could be lowered to this great an extent by using an emulsion wherein the hydrocarbon fuel particle size is substantially uniform and in the range of 0.1 to 1.0 microns as compared to employing the emulsion of '025 having particles of 10 microns and less.

It is believed that this difference in performance between the emulsion fuels of '025 and the emulsion fuels of the present invention is due to the difference in particle size. Nothing in '025 teaches that its emulsion have a particle size substantially uniform and in the 0.1 to 1.0 micron range. All '025 teaches, suggests or implies is that its particle size be 10 microns or less.

Based on '025, one would have expected fuel-in-water emulsions, regardless of particle size, to generate substantially similar results within the 6 to 44% range reported in '025 at various loads. Nothing in '025 can be seen as teaching, suggesting or implying a PM emissions reduction of between 53 to 91.5% compared to Swedish Class I Diesel, upon combustion of a FT fuel-in-water emulsion wherein the FT fuel particle size is substantially uniform in the range of 0.1 to 1.0 microns. Nothing teaches, suggests or implies that the level of PM emissions can be reduced to from 53% to 91.5% below those of Swedish Class 1 Diesel fuel nor provides any teaching or suggestion as to how to achieve such an improved level of particulate matter emissions reduction and clearly does not suggest that the level of particulate matter emissions could be improved (i.e., reduced) by reducing the particle size of the fuel emulsion.

Nothing in '025 teaches, suggests, implies or motivates one skilled in the art to reduce the particle size of the emulsion to 0.1 to 1.0 microns which, as applicants have demonstrated, unexpectedly achieves a reduction in particulate matter emissions of 53 to 91.5% as compared to Swedish Class 1 Diesel fuel which is an industry standard low emissions reference diesel fuel.

Claims 1 and 9 have been amended to incorporate the limitations of claims 15 and 16 to recite that the particulate matter emissions produced upon combustion in an engine of the hydrocarbon-in-water emulsion are 53 to 91.5% lower as compared to the particulate matter emissions produced upon combustion in an engine of Swedish Class 1 Diesel fuel.

The arguments previously presented in regard to the Examiner's rejection of claims 15 and 16 under 35 USC §112 first paragraph are adopted here in regard to the present amendments to claims 1 and 9.

Applicants take this opportunity to bring to the attention of the United States Patent and Trademark Office these additional references: WO 03/057793 and WO 03/064566.

It is requested that the Examiner reconsider this application in light of the amendments made to the claims and the above remarks that she withdraw the rejection, allow the claims as amended and pass the case to issue in due course.

Respectfully submitted,

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